Exam.Code:0905
Sub. Code: 6204

2123
B.E., First Semester
ASP-X02: Quantum Physics
(CSE, IT)

Time allowed: 3 Hours | Max. Marks: 50

NOTE: *Attempt five questions in all, including Question No. I which is compulsory and selecting two questions from each Part.*

x-x-x

1. Attempt the following questions. **(5 x 2 =10)**

(a) What was the objective of Michelson Morley Experiment? How is the result of the experiment interpreted?
(b) What are the salient features of Blackbody radiation spectrum?
(c) Find the value of the commutator $[x, p_x]$.
(d) What do you mean by degenerate energy states?
(e) What are the drawbacks of classical free electron theory?

Part-A

2. (a) Derive the relativistic expression for kinetic energy of a body and show that for smaller speeds, it reduces to classical expression. (4)
(b) Using Lorentz transformation equations, derive the relativistic velocity transformation equations. (4)
(c) An electron and a photon both have momenta of 2 MeV/c. Find the total energy of each. (2)

3. (a) What is Compton Effect? Derive expressions for Compton shift of scattered photon and the recoil energy of the electrons. (5)
(b) What do you mean by phase velocity (v_p) and group velocity (v_g) of a wave? Show that for a wave packet with a particle moving with a velocity v

$$v_p \times v_g = c^2$$ (3)

(c) Using uncertainity principle, estimate the radius of 1st Bohr's orbit. (2)

4. (a) Establish the operator form of steady state Schrodinger wave equation. (4)
(b) How does the production of X-rays support the particle nature of electromagnetic radiation? Explain. (3)
(c) For a particle constrained to move along x axis between x=0 and x=L, having represented by a wave function $\psi = Ae^{ikx}$, find the values of normalization constant and $< x^2 >$. (3)

Part-B

5. (a) Find out the transmission probability for an electron, with energy E, incident on a potential barrier V_0, when energy of electron $E < V_0$. A 1 eV electron gets trapped inside a metal. If the potential barrier is 4.0 eV and the width of the barrier is 2 Å, calculate the probability of its transmission (6)
(b) Show that the energy of a particle trapped in an infinitely rigid box is quantized. (4)

6. (a) Write down the Schrodinger equation for the harmonic oscillator and compare the probability densities of the quantum mechanical oscillator with that of a classical oscillator. Also show how this harmonic oscillator problem is in accordance with correspondence principle. (7)
(b) A beam of particles, each with energy 40 MeV approaches a step potential of height 30 MeV. What fraction of the beam is reflected and transmitted? (3)

7. (a) Explain the formation of energy bands in solids using Kronig Penney Model. Also discuss the behaviour of electrons in the Kronig Penney model in the limit of very high and very low potential barriers. (5)
(b) Discuss the variation of Fermi Dirac distribution function with temperature. Fermi energy of conduction electrons in silver is 5.48 eV. Calculate the number of such electrons per cubic cm. Atomic mass of Ag is 107.8 amu. (5)

x-x-x